

Field-User Acceptability of New Camouflage Face Paint Formulations in the Republic of Korea

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New formulations of camouflage face paint (CFP), one with 30% *N,N*-diethyl-3-methylbenzamide (DEET) and the other without DEET, were evaluated for soldier-user acceptability during a military field-training exercise in the Republic of Korea. Soldiers testing the CFP formulations were members of one of four U.S. Army infantry companies (A, B, C, or D). The formulations were evaluated while soldiers participated in simulated combat exercises for 5 days during hot, humid summer weather in Korea. Results showed that soldiers found both of the new formulations easier to apply (91.3% of respondents who used CFP without DEET and 87.9% of respondents who used CFP with DEET) and remove (82.6% without DEET and 81.2% with DEET) than the previous standard military-issue CFP. Soldier acceptability was higher for the new CFP formulation with 30% DEET (70.5%) than for the formulation without 30% DEET (52.9%). Soldiers recommended it more frequently (70.5%) than the formulation without 30% DEET (50.0%). The new CFP formulation with 30% DEET was rated more often (79.5%) as either good or excellent than the new formulation without 30% DEET (67.4%). Soldiers reported that the CFP formulation with 30% DEET more successfully camouflaged the face (92.7%) than the formulation without 30% DEET (80.0%).

Introduction

The Walter Reed Army Institute of Research (WRAIR), in collaboration with the Deputy Chief of Staff, Force Health Protection, 18th Medical Command, and the Division Surgeon, 2nd Infantry Division, conducted an important field study to evaluate the user (soldier) acceptability of a new standard military camouflage face paint insect repellent (CFPIR) during a training exercise in the Republic of Korea (ROK) in July 2001. This field trial was essential to the development of the camouflage face paint (CFP) with 30% *N,N*-diethyl-3-methylbenzamide (DEET) repellent that resulted in a product to protect soldiers from arthropod-borne diseases in tactical situations.

During the Korean War, vivax malaria, Japanese encephalitis (JE), and scrub typhus were significant civilian and military public health threats throughout the Korean peninsula.¹⁻³ Subsequent to the war, the ROK was declared malaria free in the late 1970s.⁴ For the last two decades, there have been few reported cases of JE as a result of a mandatory childhood vaccination

program. However, the virus is maintained in a zoonotic cycle and remains a public health threat for many nonvaccinated U.S. soldiers.⁵ Scrub typhus continues to be a major health threat but is effectively treated in nonpregnant adults with doxycycline when correctly diagnosed.⁶

The recent reemergence of vivax malaria (>4,000 cases in 2000), after a hiatus of more than one decade, has raised awareness of arthropod-borne diseases in the Korean peninsula. In addition, many U.S. soldiers remain unvaccinated against JE, and all are susceptible to scrub typhus.⁷⁻⁹ During a survey near the Demilitarized Zone (DMZ) in 2000, 14 isolations of JE virus were made from approximately 3,500 *Culex tritaeniorhynchus* Giles.⁵ This and the fact that the vector populations were very abundant (>3,000 collected per trap night in Mosquito Magnets at Kunsan Air Base, ROK, and up to 1,000 mosquitoes per trap night in its northernmost distribution in the ROK) demonstrated the risk to many U.S. soldiers who were not vaccinated against JE virus.¹⁰ Additionally, there was an increase in tick-borne diseases in the ROK.¹¹⁻¹⁵ These tick-borne human pathogens (*Ehrlichia* and *Anaplasma* spp.), identified among tick populations near the DMZ, may result in nonbattle casualties that could adversely affect military operations.^{16,17}

Soldiers are trained to use CFP to prevent being seen by the enemy forces. The application of CFP and insect repellents is a time-consuming procedure that soldiers do not always have time to conduct. The inclusion of an insect repellent in the CFP protects soldiers by reducing their visibility to the enemy and by preventing arthropod bites on the exposed skin. Combined with the permethrin-treated uniform, the CFP with repellent should provide nearly complete protection from arthropod bites. New products that incorporate repellents as an active ingredient in the CFPs must meet several rigorous criteria, and soldier acceptance of these products is paramount. Thus, since the effectiveness of the new CFPIR formulation containing 30% DEET was previously tested in the laboratory¹⁸ and in the field,¹⁹ in this study we simply quantified the levels of its acceptance by the soldier.

Materials and Methods

Test Materials

A user-acceptability trial of two different CFP formulations (Iguana, LLC, Thomasville, Georgia) was conducted during a military field exercise in the ROK during July 2001. The ingredients used in the CFPIR formulation were ceresine wax, castor wax, mineral oil (heavy viscosity), cosmetic yellow, cosmetic green (hydrous and anhydrous), cosmetic black, cosmetic burnt sienna, titanium oxide (Atlas white), and 30% DEET. Although only one of the CFP formulations contained 30% DEET, all

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soldiers had access to the standard army insect repellent, extended-duration topical insect and arthropod repellent (EDTIAR), and permethrin-treated battle dress uniforms for protection from biting arthropods.

Volunteers

The minimal-risk human use protocol (Field User Acceptability Evaluation of New Formulations of Camouflage Face Paint and Camouflage Face Paint Insect Repellent, WRAIR No.882) was reviewed by a Scientific Review Committee and approved by the Human Use Review Committee, WRAIR (Silver Spring, Maryland). Participating soldiers provided informed consent in accordance with research guidelines for studies with humans (Institutional Review Board at the U.S. Army Medical Research and Materiel Command, Fort Detrick, Frederick, Maryland). Volunteer soldiers were assigned to either A, B, C, or D Company, 1st Battalion, 503rd Infantry Regiment Air Assault, 2nd Infantry Division, 8th U.S. Army. Soldiers were assigned to one of two groups: those in Companies A ($n = 77$) and B ($n = 98$) received the new CFPIR formulation containing 30% DEET, whereas soldiers in C ($n = 86$) and D ($n = 87$) received the new CFP formulation without DEET and the standard U.S. military's EDTIAR containing 35% DEET. Initial briefings, signing of informed consent forms, and distribution of CFP plus EDTIAR and CFPIR test materials were completed on July 23, 2001, before soldiers deployed to the training sites. Soldiers completed user-acceptability questionnaires comparing the two new formulations on their return from the training exercise on July 28, 2001. None of the volunteers withdrew from the study because of skin sensitivity or allergic response or for any other reason, and each completed the study by responding to the pre- and posttrial questionnaires.

Study Sites

This study was conducted during a scheduled U.S. Army training exercise north of Camp Casey, near the city of Dongducheon in the ROK at the Multiple Purpose Range Complex (MPRC) (Blackhawk Range), and at Nightmare Range, near the DMZ which separates the ROK from the People's Democratic Republic of Korea. Soldiers spent 5 days participating in simulated combat exercises during hot and humid summer weather. MPRC is a mountainous area interspersed with narrow valleys with intermittent/permanent streams and pine and deciduous forests. The narrow valleys are lined with willows, shrubs, and tall grasses. Agriculture is the main activity along the border of MPRC and residential housing is limited. Nightmare Range is located near the peak of a very mountainous region interspersed with steep narrow valleys with intermittent/permanent mountain streams. The primary vegetation is mixed pine and deciduous forests.

Study Design

The primary objective of the study was to compare the performance of the two new CFP formulations by measuring the proportion of soldiers providing negative, neutral, or positive responses to eight questions regarding user-product acceptability. Data were coded and entered into Minitab (State College, Pennsylvania) worksheets. Informative tables and graphical displays of summary descriptive statistics were constructed to con-

trast the treatment groups. Contingency tables were used to contrast proportions. Estimation of the difference in proportions and the odds ratios was used to compare binary responses. Tests and confidence intervals were based on the approximate normality of the difference in sample proportions.

Because randomization was not used to assign volunteers to treatment groups, the difference in acceptance rates between the CFP formulations (with and without 30% DEET) may not safely be attributed to treatment differences. That is, the estimated relationships might be related to confounding variables. Nevertheless, all four companies were tested during the same time period and were subjected to the same environmental conditions, so that the results would not be affected by these potential confounding variables. Another caveat is that the experiment was not blinded (volunteers knew whether the CFP contained 30% DEET); thus, knowledge of the treatment represented another factor that might be responsible for statistical differences between groups. It was not possible to blind the study, because (1) Environmental Protection Agency labels were required on the formulation compacts, (2) the CFPIR had a slight repellent odor, and (3) the group provided only CFP was also given the EDTIAR formulation. Although these considerations were counter to the usual statistical precautions taken in testing a medical intervention such as a drug, they were not as damaging to the design of a study intended to test user acceptability.

User-Acceptability Test Procedure

Each soldier was given one compact containing either the new formulation of CFPIR (A and B Companies) or the new formulation of CFP with no repellent (C and D Companies). Soldiers were instructed to use the CFP and CFPIR according to standard tactical operating procedure during the 5-day field-training exercise. For the CFP without repellent, soldiers were instructed to use the product according to doctrine, which includes the application of the standard military insect repellent, EDTIAR, 30 minutes before application of the CFP formulation. Before entering the training site, all participating soldiers completed Part I of the questionnaire, covering their previous experience with CFP, field-training exercises, and contingency deployments. All of the participating soldiers completed Part II of the questionnaire, which evaluated the performance of the products, after they returned to their duty station, Camp Casey.

Statistical Analysis

The primary analysis was performed to compare the performance of the two CFP formulations by measuring the proportion of soldiers providing negative, neutral, or positive responses to eight questions regarding user acceptability of the product. Significant differences ($p < 0.05$) between proportions were analyzed using confidence limits of proportions according to the binomial distribution.²⁰ A χ^2 test (two groups) with a 0.05 two-sided significance level would have 98% power to detect the difference between proportions among group 1 (0.40) and group 2 (0.60) (odds ratio of 2.25) when the sample size in each group is 200.

Results

Profile of Experience and Background

A total of 348 eligible soldiers volunteered and participated in this study (Table I). The two test populations were similar in

TABLE I
TREATMENTS USED BY EACH COMPANY PARTICIPATING IN THE STUDY

Company	Participants	Treatment	Source
A	77	New formulation CFPIR	Iguana, LLC
B	98	New formulation CFPIR	Iguana, LLC
C	86	New formulation CFP and standard military insect repellent	Iguana, LLC/military supply
D	87	New formulation CFP and standard military insect repellent	Iguana, LLC/military supply

experience and background (Table II). As might be expected in combat arms, the average age within each company was <25 years (mean, 24.5 years; range, 18–43 years) and the most common rank was E-4 (Specialist). Of the 348 study volunteers, 100% were men; 215 (61.8%) were Caucasian, 46 (13.2%) were African American, 39 (11.2%) were Asian, 37 (10.6%) were Hispanic, 4 (1.1%) were Native American Indian, 3 (0.8%) were Pacific Islander, and 4 (1.1%) were another ethnic group (Fig. 1).

Performance of CFP

The performance of the CFP formulations was assessed by five specific and three general questions, as well as unstructured written comments. The responses to each question are summarized in Table III and are as follows:

Specific questions: (1) *How easy or difficult was it to apply this product to your face?* There was no significant difference between the proportions of soldiers reporting that the formulations were easy to apply (91.3% in the CFP group and 87.9% in the CFPIR group, Z score = 1.02, p = 0.31), indicating that both formulations were equally easy to apply. (2) *Did this product perform its function of camouflaging your face?* There was a significant difference between the two test populations in the answer to this question. The CFPIR group was more satisfied (92.7% vs. 80.0%) with how the formulation functioned in terms of camouflaging them (Z score = 3.45, p = 0.001). (3) *How did this product feel on your skin?* There was no significant difference between how the two test populations rated the feeling of the formulations on the skin (Z score = 1.27, p = 0.20). (4) *Did you have enough of this product to use?* Overall, there was no difference between the two groups (Z score = 1.32, p = 0.18), and virtually every soldier had a sufficient quantity of face paint during the 5-day exercise (97.7% for the CFP group and 99.4%

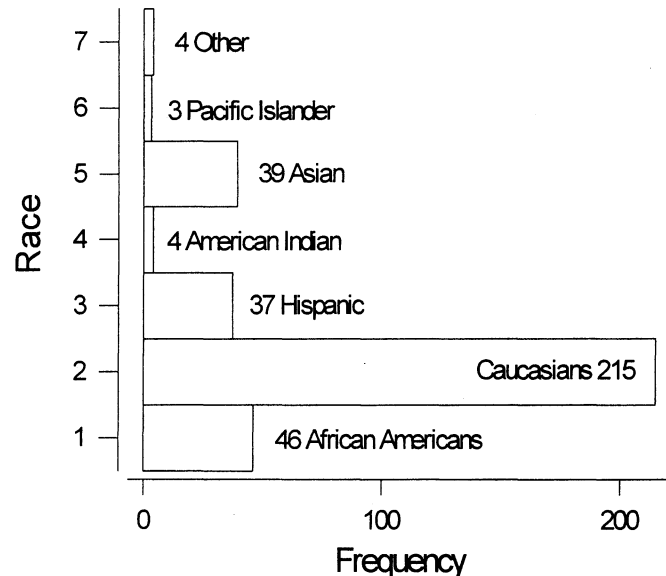


Fig. 1. Demographic data.

for the CFPIR group). (5) *How easy or difficult was it to remove this product?* Again, each formulation was rated similarly, and there was no significant difference in removal characteristics (Z score = 0.32, p = 0.75).

General questions: (6) *Would you accept this product for future use?* The difference between proportions answering positively was highly significant (Z score = 3.38, p = 0.001). The CFPIR formulation was considered more acceptable for future use (70.5% vs. 52.9%). (7) *How would you rate this product?* This question also yielded a significant difference between the two populations (Z score = 2.54, p = 0.01), and the CFPIR was more frequently rated as good. (8) *Would you recommend this product to another soldier who needs to use it?* This question resulted in the most significant difference between populations (Z score = 3.94, p < 0.001). Once again, the CFPIR formulation outperformed the CFP formulation (70.5% recommended CFPIR to other soldiers and only 50.0% recommended CFP).

Discussion

The primary objective of this study was to compare the performance of the two new CFP formulations by measuring the proportion of soldiers providing negative, neutral, or positive responses to eight questions regarding user acceptability of the product. We did not ask the soldiers about the protective (insect repellent) quality of the CFPIR, because this factor was previously addressed in a laboratory¹⁸ and in a field user-acceptability test in Thailand¹⁹ in which the CFPIR was effective against the disease vectors. The new CFPIR compact with 30% DEET

TABLE II
SUMMARY OF EXPERIENCE AND BACKGROUND OF SOLDIERS

Experience	A/B Companies (CFPIR)	C/D Companies (CFP)
	Mean \pm SD (range)	
Years of service	4.5 \pm 4.6 (0–22)	4.5 \pm 4.7 (0–22)
Age (years)	24.5 \pm 5.3 (18–42)	24.6 \pm 5.5 (18–43)
Months deployed	14.8 \pm 17.2 (1–120)	13.0 \pm 16.61 (1–100)
No. of field exercises	25.5 \pm 29.8 (1–101)	15.5 \pm 21.5 (1–100)
	Mode (range)	
Rank	E4 (E1–E8, O1–O3)	E4 (E1–E8, O1–O3)
	No. (%)	
Used face paint	158	162
Never used	16	13
Had malaria	2	2
Never had	148	159
Didn't know	24	14

TABLE III
SUMMARY OF RESULTS FROM QUESTIONNAIRE EVALUATING NEW FORMULATIONS OF CFP AND CFPIR

Survey Question	Percent		Measure of Effect Difference (95% Confidence Interval)	Z Score (p)	Acceptability Conclusion
	CFP	CFPIR			
Question 1: Easy application	91.3	87.9	0.034 (-0.031, 0.099)	1.02 (0.31)	No difference
Question 2: Successful function	80.0	92.7	0.127 (0.055, 0.199)	3.45 (0.001)	30% DEET wins
Question 3: Good feeling on skin	69.2	62.7	0.065 (-0.036, 0.166)	1.27 (0.20)	No difference
Question 4: Sufficient quantity	97.7	99.4	0.017 (-0.008, 0.043)	1.32 (0.18)	No difference
Question 5: Easy removal	82.6	81.2	0.013 (-0.069, 0.096)	0.32 (0.75)	No difference
Question 6: Accept for future use	52.9	70.5	0.176 (0.074, 0.278)	3.38 (0.001)	30% DEET wins
Question 7: Good rating	67.4	79.5	0.121 (0.028, 0.214)	2.54 (0.01)	30% DEET wins
Question 8: Endorse to other soldiers	50.0	70.5	0.205 (0.103, 0.307)	3.94 (<0.001)	30% DEET wins

holds twice the amount of product (20 applications of green, loam, and sand, and 10 applications of Atlas white and black compared with approximately 10 applications in the 2-ounce standard repellent tube), contains a large mirror, and replaces two items with one, thus saving space, reducing weight of the individual survival kit, and saving time in dual application. In addition, the new CFP formulations are Environmental Protection Agency registered, comply with all safety criteria, and meet soldier acceptability standards. This user-acceptability study was a requirement for the final product development process for field use of the CFP and CFPIR formulations.

The U.S. military is one of the best-equipped military forces in the world. Among the arsenal of tools available to soldiers are devices and procedures that result in greater safety for the individual. Whether the objective of the product is prevention of casualties from enemy action (Force Protection) or prevention of casualties from disease (Force Health Protection), the net result is a requirement for a smaller force that requires fewer replacements during a deployment. CFP is a traditional means of augmenting Force Protection by hiding the soldier from enemy fire. Adding insect repellent to the CFP integrates Force Health Protection into the product, further reducing the likelihood that the soldier will be taken out of action. Soldier evaluations of the new CFP formulations were essential for implementing new strategies in the control of vector-borne diseases during military operations. This study clearly documented that the new CFP, either with or without 30% DEET, was superior to the CFP previously used by the U.S. military. The specific characteristics of both of the new CFP and CFPIR formulations were similar, except the CFPIR formulation was better at camouflaging the skin. Thus, the 30% DEET component resulted in a product that was more easily spread over the skin areas and provided the additional benefit of protecting the soldier against arthropod bites. Products produced by the military that are found by soldiers to be ineffective are less likely to be used. Therefore, the most important result from this study was the overwhelming acceptance of the CFPIR formulation (>70%) compared with the CFP formulation (50%).

The significantly different responses to soldiers' acceptance, rating, and recommendation of the new CFPIR formulation in the presence of large populations of biting mosquitoes suggested that the performance and effectiveness of the CFPIR formulation were superior overall to CFP plus EDTIAR. In addition, the CFPIR formulation provides dual protection and does not require the soldier to first apply the insect repellent, wait for a period of time, and then apply the CFP. Also, the reapplication of the current insect repellent caused the previously applied CFP to smear, reducing its effectiveness in protecting the soldier.

Conclusions

In summary, measures that protect the soldier from more than one scenario assist in the further reduction of disease and nonbattle injuries among military personnel, whether training or during military operations. The higher acceptance of these new CFP formulations, particularly CFPIR, by the infantry soldiers ensures that these products will be used in the field. In addition, the new CFP compact is an improvement over the previous version, because it provides more colors (black and Atlas white) and includes a large practical mirror. The two new formulations of CFP are now available in the military supply system under the following National Stock Numbers: 6840-01-493-7334 for CFP with 30% DEET and 6850-01-493-7309 for CFP without insect repellent. The CFP with repellent enables troops in the field to simultaneously apply camouflage and protect themselves from disease vectors and nuisance arthropods, whereas the repellent-free option is useful in non-field-training environments or times and locations where arthropods are not a threat.

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